

CLAIMS

WHAT IS CLAIMED IS:

1. 1. A method of copying data, comprising operations of:
 2. receiving a request to copy a body of source data to specified target storage;
 3. reviewing contents of the source data to identify data objects therein;
 4. for each identified data object, performing copy operations comprising:
 5. consulting prescribed metadata records to determine whether a copy of the identified data object already exists in the target storage;
 6. only if a copy does not already exist, performing operations comprising:
 7. applying prescribed criteria to determine whether the identified data object qualifies for copying;
 8. forming a copy of the identified data object in target storage,
 9. comprising:
 10. if the data object qualifies for copying, writing the data object to the target storage;
 11. if the data object does not qualify for copying, instead of writing the data object writing a predetermined bit pattern to the specified target storage;
 12. responsive to completion of the forming operation, updating the metadata records to indicate that the data object exists in the specified target storage regardless of whether the data object

was replaced with a predetermined bit pattern rather than being physically written to the specified target storage.

2. The method of claim 1,

the reviewing operation comprising reviewing contents of the source data to identify individual data objects therein, and also reviewing any aggregate data objects in the source data to identify all constituent data objects thereof;

where the applying and forming operations are performed separately for each data object whether in individual or aggregated form;

where the operation of updating the metadata records comprises,

for each data object comprising an individual data object, preparing a record indicating that the data object exists in the specified target storage regardless of whether the data object was replaced with the predetermined bit pattern rather than being written to the specified target storage;

for each data object comprising an aggregated data object, preparing a record indicating that the data object exists in the specified target storage regardless of whether any constituent data objects were replaced with the predetermined bit pattern rather than being written to the specified target storage.

3. The method of claim 2, for each data object comprising an aggregated data object, further comprising one of the following operations:

3 forming a record indicating whether the aggregated data object contains any
4 constituent user files replaced with the predetermined bit pattern;
5 forming a record specifically identifying any constituent user files replaced with the
6 predetermined bit pattern.

1 4. The method of claim 2, further responsive to completion of the forming operation,
2 performing operations comprising preparing a metadata record to identify each individual
3 data object that was replaced with a predetermined bit pattern rather than being written to
4 target storage.

5. The method of claim 2, the operations further comprising:
1 receiving a request to restore one or more specified data objects from the target
2 storage to a specified restore site;
3 for each specified data object, performing restore operations comprising:
4 consulting the metadata records to identify one or more copies of the specified
5 data object in the target storage;
6 if the specified data object is an individual data object, searching the metadata
7 records to locate a copy in which the data object was not replaced with
8 the predetermined bit pattern;
9 if the specified data object is an aggregate data object, searching the
10 metadata records to locate copies of the constituent data objects in
11 which the constituent data objects were not replaced with the
12 predetermined bit pattern;
13

- 14 copying each copy located by the search to a specified restore site.
- 1 6. The method of claim 1, the applying operation comprising one or more of the
2 following:
3 consulting a previously prepared record designating data objects as qualifying or not;
4 applying prescribed criteria to characteristics of the data object to determine whether
5 the data object qualifies or not.
- 1 7. The method of claim 1, further comprising reclaiming space in the copy by performing
2 the reviewing, applying, and forming operations to the copy.
- 1 8. A signal-bearing medium tangibly embodying a program of machine-readable
2 instructions executable by a digital processing apparatus to perform operations to copy data,
3 comprising:
4 receiving a request to copy a body of source data to specified target storage;
5 reviewing contents of the source data to identify data objects therein;
6 for each identified data object, performing copy operations comprising:
7 consulting prescribed metadata records to determine whether a copy of the
8 identified data object already exists in the target storage;
9 only if a copy does not already exist, performing operations comprising:
10 applying prescribed criteria to determine whether the identified data
11 object qualifies for copying;

12 forming a copy of the identified data object in target storage,
13 comprising:
14 if the data object qualifies for copying, writing the data object to
15 the target storage;
16 if the data object does not qualify for copying, instead of writing
17 the data object writing a predetermined bit pattern to the
18 specified target storage;
19 responsive to completion of the forming operation, updating the
20 metadata records to indicate that the data object exists in the
21 specified target storage regardless of whether the data object
22 was replaced with a predetermined bit pattern rather than being
23 physically written to the specified target storage.

9. The medium of claim 8,
the reviewing operation comprising reviewing contents of the source data to identify
3 individual data objects therein, and also reviewing any aggregate data objects
4 in the source data to identify all constituent data objects thereof;
5 where the applying and forming operations are performed separately for each data
6 object whether in individual or aggregated form;
7 where the operation of updating the metadata records comprises,
8 for each data object comprising an individual data object, preparing a record
9 indicating that the data object exists in the specified target storage
10 regardless of whether the data object was replaced with the

11 predetermined bit pattern rather than being written to the specified
12 target storage;

13 for each data object comprising an aggregated data object, preparing a record
14 indicating that the data object exists in the specified target storage
15 regardless of whether any constituent data objects were replaced with
16 the predetermined bit pattern rather than being written to the specified
17 target storage.

1 10. The medium of claim of claim 9, the operations further comprising, for each data
2 object comprising an aggregated data object, one of the following operations:

3 forming a record indicating whether the aggregated data object contains any
4 constituent user files replaced with the predetermined bit pattern;
5 forming a record specifically identifying any constituent user files replaced with the
6 predetermined bit pattern.

1 11. The medium of claim 9, further responsive to completion of the forming operation,
2 performing operations comprising preparing a metadata record to identify each individual
3 data object that was replaced with a predetermined bit pattern rather than being written to
4 target storage.

1 12. The medium of claim 8, the operations further comprising:
2 receiving a request to restore one or more specified data objects from the target
3 storage to a specified restore site;

4 for each specified data object, performing restore operations comprising:
5 consulting the metadata records to identify one or more copies of the specified
6 data object in the target storage;
7 if the specified data object is an individual data object, searching the metadata
8 records to locate a copy in which the data object was not replaced with
9 the predetermined bit pattern;
10 if the specified data object is an aggregate data object, searching the
11 metadata records to locate copies of the constituent data objects in
12 which the constituent data objects were not replaced with the
13 predetermined bit pattern;
14 copying each copy located by the search to a specified restore site.

1 13. The medium of claim 8, the applying operation comprising one or more of the
2 following:

3 consulting a previously prepared record designating data objects as qualifying or not;
4 applying prescribed criteria to characteristics of the data object to determine whether
5 the data object qualifies or not.

1 14. The medium of claim 8, further comprising reclaiming space in the copy by performing
2 the reviewing, applying, and forming operations to the copy.

1 15. A logic circuit of multiple interconnected electrically conductive elements configured
2 to perform operations to copy data comprising:

3 receiving a request to copy a body of source data to specified target storage;

4 reviewing contents of the source data to identify data objects therein;

5 for each identified data object, performing copy operations comprising:

6 consulting prescribed metadata records to determine whether a copy of the

7 identified data object already exists in the target storage;

8 only if a copy does not already exist, performing operations comprising:

9 applying prescribed criteria to determine whether the identified data

10 object qualifies for copying;

11 forming a copy of the identified data object in target storage,

12 comprising:

13 if the data object qualifies for copying, writing the data object to

14 the target storage;

15 if the data object does not qualify for copying, instead of writing

16 the data object writing a predetermined bit pattern to the

17 specified target storage;

18 responsive to completion of the forming operation, updating the

19 metadata records to indicate that the data object exists in the

20 specified target storage regardless of whether the data object

21 was replaced with a predetermined bit pattern rather than being

22 physically written to the specified target storage.

- 1 16. A data storage system, comprising:
- 2 digital data storage including a body of source data;

3 metadata;

4 a storage director, programmed to perform copy operations comprising:

5 receiving a request to copy a body of source data to specified target storage

6 of the digital data storage;

7 reviewing contents of the source data to identify data objects therein;

8 for each identified data object, performing copy operations comprising:

9 consulting the metadata to determine whether a copy of the identified

10 data object already exists in the target storage;

11 only if a copy does not already exist, performing operations comprising:

12 applying prescribed criteria to determine whether the identified

13 data object qualifies for copying;

14 forming a copy of the identified data object in target storage,

15 comprising:

16 if the data object qualifies for copying, writing the data

17 object to the target storage;

18 if the data object does not qualify for copying, instead of

19 writing the data object writing a predetermined bit

20 pattern to the specified target storage;

21 responsive to completion of the forming operation, updating the

22 metadata to indicate that the data object exists in the

23 specified target storage regardless of whether the data

24 object was replaced with a predetermined bit pattern

rather than being physically written to the specified target storage.

17. A data storage system, comprising:

 - first means for storing digital data including a body of source data;
 - second means for storing metadata;
 - third means for copying data of the digital data storage by:
 - receiving a request to copy a body of source data to specified target storage
 - in the first means;
 - reviewing contents of the source data to identify data objects therein;
 - for each identified data object, performing copy operations comprising:
 - consulting the second means to determine whether a copy of the identified data object already exists in the target storage;
 - only if a copy does not already exist, performing operations comprising:
 - applying prescribed criteria to determine whether the identified data object qualifies for copying;
 - forming a copy of the identified data object in target storage,
 - comprising:
 - if the data object qualifies for copying, writing the data object to target storage;
 - if the data object does not qualify for copying, instead of writing the data object writing a predetermined bit pattern to the specified target storage;

21 responsive to completion of the forming operation, updating the
22 second means to indicate that the data object exists in
23 the specified target storage regardless of whether the
24 data object was replaced with a predetermined bit pattern
25 rather than being physically written to the specified target
26 storage.

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